numeral *may be* connected with the Australian. On the opposite New Guinea coast the numerals for 'one' are very different to the Saibai *urapon.* They are: *nambi* (Morehead River), *ambior* (Wasi Kasa), *tarangesa* (Bugilai Tribe), *iepa* (Kunini Tribe), *atanok* (Dabu Tribe), *netat* (Murray Island), *nao* (Kiwai Island), *monou* (Purari Delta), *farakeka* (Papuan Gulf), *aia* (Yule Island). Mr. Mathew asks us to believe that the Kalkadoon numeral "*luadi*" (two) is a Melanesian numeral used in Australia 150 miles south of the Gulf of Carpentaria, when the only comparable form in Melanesia is the Duke of York Island *ruadi* (second). This is a flagrant example of the method adopted, though disavowed, by Mr. Mathew.

The point missed by Mr. Mathew in discussing the phrase "*ori kaiza*," which I called mongrel, is that he has no proof that '*ori*' and '*uroi*' are the same words. Considering that the Gulf tribes have a word (*uiva*) for 'cassowary' (the emu is not found), and that nowhere else in New Guinea is there a word similar to *ori*, meaning 'bird,' and also that it requires a Torres Straits word to give '*ori*' an Australian meaning, it is highly improbable that it can explain words like *waitch*, *wadgie*, *warritch* for "emu." The Saibai for 'big bird' is '*koi urui*,' for 'cassowary,' '*samu*.'

In his letter, Mr. Mathew objects to my calling comparisons of Australian with Malay and New Hebridean "absurd and misleading." He suggests, without any warrant, that I find the absurdity in analogies between Malay and New Hebridean, whereas I have directly affirmed the connection of Malay with Melanesian (including New Hebridean) in the *Journal* of the Polynesian Society for 1896. The real absurdity is that of supposing that there is a relationship between Australian, Malay and New Hebridean, because "the terms for father, skin are the same."

In conclusion, I must again express my regret that Mr. Mathew should regard my criticism of his work as 'mere fault-finding and ridicule.' I have studied these languages for many years (without postulating theories), and have much material yet unpublished. To point out the weakness of Mr. Mathew's argument, with regard to method and deductions is fair criticism, and should not lead to a charge of unsoundness and inaccurate knowledge. If, as Mr. Mathew states, his materials are imperfect, why found a theory upon them?

218, Balfour Road, Ilford, Essex, October 14. SIDNEY H. RAY.

RECENT AND PROPOSED GEODETIC MEASUREMENTS.

In the history of geodesy and the discussion of the problem of the figure of the earth, the measurement of three arcs of meridian stands out conspicuously. These are the Peruvian and Lapland arcs in the Northern Hemisphere, and that of Lacaille in the neighbourhood of the Cape of Good Hope. Those who took part in the original measures worthily distinguished themselves, but it is inevitable that with the demand for greater accuracy in geodetic inquiries the necessity for repeating the ancient measures should be acknowledged. Without experience and with imperfect instruments, it is remarkable that the old astronomers accomplished what they did. To determine the approximate figure of the earth, and to derive a fairly accurate value of the compression was no mean achievement. But Lacaille's arc of meridian soon fell into disrepute, and other measures have had to be substituted by Maclear and others. Svanberg repeated the original work of Clairant and his colleagues, in Lapland, soon after its completion, and within these last few years a new determination of the Peruvian arc has been imperatively called for. There is no doubt but that the French nation, who have so honourably distinguished themselves in the difficult task of geodetic measurement, will be able to undertake this work, and increase their scientific reputation. From 1734, when the enlightened Government of the day undertook the measurement of two of the aforementioned arcs, down to our own time, when we have seen the Mediterranean successfully bridged by a geodetic survey, and the interior of Africa connected in one unbroken chain with our own Shetland Islands, French men of science have played a conspicuous part in all questions connected with the true figure of the earth. At a moment therefore when the re-measurement of the famous arc of Peru has been forced upon us, it would have been with a feeling akin to disappointment if we did not find the French nation eager to repeat the historic work with all the skill that long experience has suggested, and all the accuracy that modern science demands. The report of a committee of the French Academy of Sciences, however, assures us that the ardour displayed by the French in the past is no whit abated, and that though the sacrifice of time and money is considerable, these drawbacks will be cheerfully borne. For the arc in Lapland another has been substistuted on the Island of Spitsbergen, and the necessary work of triangulation has been for some time quietly carried on under the auspices of the Russian and Swedish Governments; while at the same time, the reports of Her Majesty's Astronomer at the Cape of Good Hope tell us what is being done in the way of supplementing Lacaille's arc in the Southern Hemisphere. With this activity before us, it seems a fitting opportunity to compare the aims and the motives that inspired those who inaugurated the earliest geodetic expeditions with those that will influence and guide the latest surveys in the same or similar regions.

In the middle of the last century a distinct issue was presented to the scientific mind. Then the general figure of the earth was an undetermined problem, and whether the polar or the equatorial axis was the longer was a vexed subject of controversy. It is amusing enough now to read of the disputes between the partisans of defective observations on the one hand, and the upholders of an incomplete theory on the other. To-day no such broad issue is before us, the differences are of a more subtle character, demanding great nicety of observation and more effective analysis. Then the true difficulties of the problem were scarcely apprehended. Only a few years earlier, Fernel had attempted to determine the length of a degree by counting the number of revolutions of his carriage-wheel between Paris and Amiens, a method which recalls the earliest attempts of Eratosthenes. Picard, it is true, had recognised the necessity of employing means of greater accuracy, and had taught the true principles of geodetic measurement; but the methods pursued by his descendants, and the precautions taken to ensure accuracy and recognise the surface to which the measurements are referred, constitute almost a new science. For with accumulating materials and greater experience, it has become necessary to distinguish between three surfaces. First, the ellipsoid of revolution, which corresponds most nearly to the form of the earth; secondly, the true geoid, that is to say, the surface of equilibrium of water at rest under the influence of centrifugal force, and the attraction of the earth's mass; and, thirdly, a corrected geoid, differing but slightly from the true, in which it is attempted to eliminate the effect of unequal masses on the earth's surface and in its interior. Theory shows that the true length of the arc of meridian, measured on the corrected geoid, will be given in terms of the measured base, if the effect of local attractions has been correctly determined. It is precisely in overcoming the difficulty of correctly eliminating the effect of local attractions, and of reducing the length of the measured base to the level of the water surface of the geoid, that the measurements of this century will mainly differ from those of the last.

A preliminary survey of the district undertaken by Captains Maurain and Lacombe has shown that the country of Peru possesses peculiar difficulties for an accurate geodetic survey. The levels vary very considerably with the distance from the coast, while here and there mountains of a volcanic character rise to a height of 6000 metres. But for the interest attaching to a historic site, and the desirability of continuing measurements outside middle latitudes to which they have hitherto been almost entirely confined, a project involving so many hardships might well be abandoned. Not the least interesting part of the report of Captain Maurain is his description of the country in which the pioneers of the last century carried out their observations, often on the slopes of mountains rising abruptly to the height of some 3000 metres. Of this monumental work scarcely a vestige remains, and the original line of route can be traced only from the written records. The care with which the fundamental points in a triangulation are now marked was not appreciated in those early days, and even the pyramids constructed to commemorate the ends of the arc, and the successful termination of the work, have been demolished by the Indians, who hoped to find buried treasure under the monuments, though the jealousy of the Spaniards has led to almost equally deplorable results.

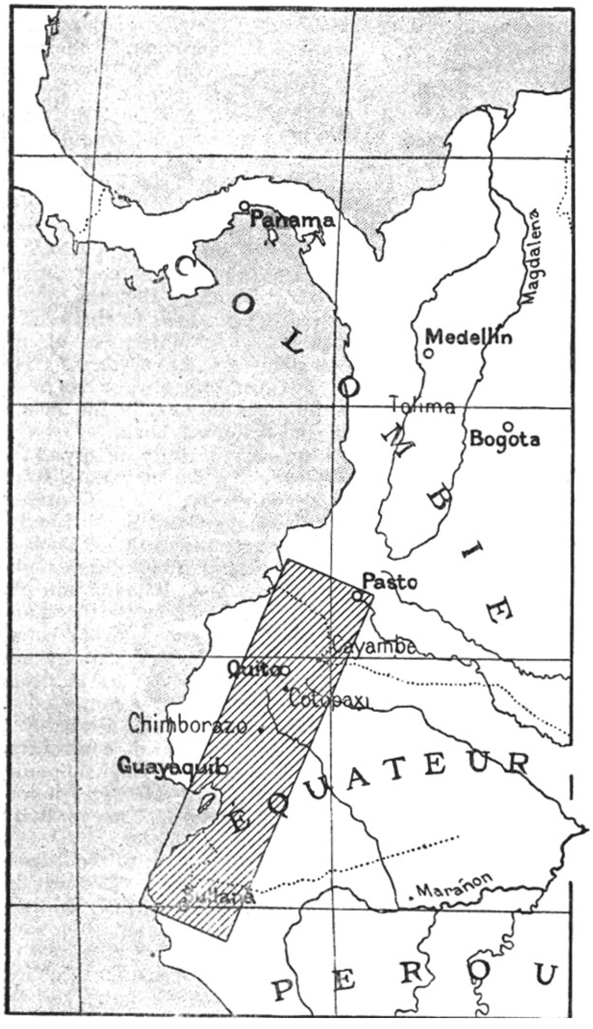

FIG. 1.—The shaded portion of the map shows the district in which the measurements will be made.

But the enterprise of the French will not be contented with the simple re-measurement of the arc of Bouguer, which extended from the environs of Quito on the north to Cuenca, somewhat south of Guayaquil (Fig. 1). Captain Maurain's instructions led him to examine the country north and south of these stations, with the view of extending the arc to six degrees of latitude. In neither direction does the task become more simple. Towards the north the two chains of the Cordilleras unite in a confused mass, bristling with numerous summits, rising to an altitude only less than that of Chimborazo or Cotopaxi. On the southern side the country becomes more open, but covered with forests, and with a wet climate, suggestive of fever. Nevertheless, it seems possible to push northwards as far as Pasto in Columbia, and southwards to the Peruvian town of Sullana, an arc of six degrees, or about double that originally measured. The Finance Minister asks, as Finance Ministers will, whether it is absolutely necessary to carry the arc beyond the limits of the ancient survey, and the answer of the French Academicians, as might have been anticipated, is to insist on the maintenance of the whole scheme as contemplated in the preliminary examination.

The entire programme is vast, and worthy the best traditions of French science. Three bases of about eight or nine kilometres in length will be measured, one approximately central, and two of verification at the north and south ends respectively. The difference of level between the central base and the sea at Guayaquil, where tide gauges will be erected, will be determined with the greatest nicety. Throughout the arc fifty-two stations will be selected for observation, of which three will be fundamental, and the longitudes be determined by telegraph. Magnetic observations will be carried on as a matter of course, and in a country marked by so many mountain masses special care will be taken to determine their extent and density, with the view of eliminating the effect of local attraction. But, after all precautions, it is not impossible that the measures be made on a lengthened protuberance on the surface of the geoid, and that the curvature of the line of route should differ sensibly from that which would be found along a line nearer to the Pacific or further inland. To decide this point, two methods are proposed—one by means of pendulum observations, which will give the variation of gravity throughout the whole region; the other, by determining the difference of geodetic and astronomical longitudes between a point on the coast and the observatory at Quito. The army of experts who have examined the plan and arranged the details assures us that no difficulty has been overlooked, and as a result an admirably equipped expedition will leave France next spring, to take up quarters on the equator, where four years' hard and anxious work awaits the members.

As already mentioned, towards the polar end of the quadrant the expedition under the Russians and Swedes has already made good progress. The arc measured by Maupertuis and Clariaut extended through only fifty-seven minutes in the latitude 66°, and Svanberg attempted no greater distance than $1\frac{1}{2}^{\circ}$. But the modern scheme includes an arc of more than 4° in length, in the much higher latitude of 77°–81°. The general control is in the hands of H. Sergieffsky, and trained as he has been in the accurate school of Pulkowa, admirable results may be expected. The difficulties to be encountered are probably not less, though of a different kind to those that await the French in the tropics. Fifty stations will be occupied in the course of the triangulation, which compares satisfactorily with the fifty-two of the French scheme. Two base lines only will be measured, in which it is proposed to use Jäderin's steel tape line twenty metres long. Very little is known of the success that has attended this method, though its accuracy is vouched for by Dr. Döllen's careful examination, and the French prefer to rely upon the same apparatus that was used in the determination of the French meridian. It was expected that the field-work in Spitsbergen would be finished this summer, but we are still waiting information concerning the amount of progress that has been made.

Lacaille's arc of meridian, measured in 1752, and practically the only measurement effected in the Southern Hemisphere, was long a subject of perplexity in all theoretical investigations of the figure of the earth, since the result indicated that the earth's surface was less curved in the Southern than in the Northern Hemisphere; but though the verification of the arc was an urgent necessity, it was not till 1840 that Sir Thomas Maclear commenced the work that solved the difficulty. The apparently anomalous result offers a good instance of the effect of local attraction in disturbing astronomical latitudes. The astronomical amplitude of Lacaille's arc (1° 12′) was proved to be very nearly correct, but a large local disturbance of the direction of gravity at the northern end caused a zenithal error of some 8″. Maclear enlarged the arc to nearly 5°, and here geodetic operations practically ceased, till the present astronomer, Sir David Gill, developed a scheme which dwarfs into insignificance all previous measures, and which, if it can be carried out, will prove of the utmost scientific value. He regards all that has been accomplished in South Africa as the first step in a chain of triangulation which, approximately traversing the 30th meridian of east longitude, shall extend continuously through Africa to the mouth of the Nile. He would make his chain follow, or rather precede, the line of that taken by Mr. Rhodes's transcontinental telegraph, proceeding northwards along Lake Tanganyika, through the region of the Lakes Albert and Victoria Nyanza, and along the Nile Valley. The definite survey of Egypt has not yet been undertaken, but commercial and political motives will doubtless soon bring this within the domain of practical science, and assist the onward progress of the scheme. Sir David Gill does not stop at the shores of the Mediterranean. Onwards, by an additional chain of triangles from Egypt along the coast of the Levant and through the isles of Greece, he would connect the African arc with the existing European systems, till it reached an amplitude of 105°. Sir David Gill puts before us a number of considerations by which such a scheme might be carried to a successful issue, without by any means minimising the difficulties which his experience teaches him stand in the way. It is not necessary to dwell on these obstacles, some of which are sufficiently obvious. It should, however, be remembered that no other meridian offers greater, if equal, facilities, or furnishes a better prospect for the realisation of this magnificent scheme. Sir David Gill has not confined his attention merely to the elaboration of schemes; he has accomplished much good work himself, often with straitened means, and by his personal influence and indefatigable energy aided and encouraged others. Under his auspices a chain of triangles has been carried eastward from Cape Town to Port Elizabeth, whence two branches have been carried to the north, one ending at Kimberley, while the other, crossing Natal, stops for the present at Newcastle in the extreme north of the colony. Much exploring work, hardly inferior in point of accuracy, has been carried through Bechuanaland and northwards along the 20th meridian, marking the boundary between German and British South Africa. His latest report tells us that on the eastern side of the continent stations were occupied from Bongwe (Lat. 19° 51′ S., Long. 30° 19′ E.) to a point in 16° 30′ S., and within sixty miles of the Zambesi. There the smoke from extensive grass fires compelled stoppage of field-work for the season, and his party retired to the observatory to occupy themselves in the work of reduction. The outbreak of the war and interruption by the Boers of telegraphic communication with Cape Town have for the moment delayed the determination of longitude of distant stations, but we may be sure that once the country has settled down to normal conditions, Sir David Gill will be ready to prosecute his scheme with the ardour that has ever characterised his undertakings.

RECENT ANTARCTIC BOOKS.[1]

THE long-continued neglect of Antarctic exploration has given place to a period of great activity. Several expeditions have, during the last five years, been hovering on the margin of the unknown, and penetrating within it a few steps farther than their predecessors. Great preparations are being made for what ought to prove the most determined effort to explore and study those regions by means of simultaneous national expeditions from this country and from Germany, and the public will soon begin to ask where the Antarctic regions may be and why people wish to go there.

The forerunners of the inquiring public have hitherto been obliged to cull such information as may be obtainable by the tedious process of consulting the records of original voyages which have been "out of print" for a generation at least; but in 1898 Dr. Karl Fricker came to their aid by producing his admirable compilation, "Antarktis," the introductory volume of Kirchhoff and Fitzner's "Bibliothek der Länderkunde." Of this book it is impossible to speak too highly, and we must congratulate the editors and publishers of the series on their choice of a beginning. We must congratulate the English publishers also on having the courage to show the British public how much better the results of British pluck and enterprise are appreciated in Germany than at home. We know nothing less pleasant to contemplate with regard to the long Antarctic record than the apathy of the British public and publishers alike to the pioneer work of Cook, the public-spirited enterprise of the Enderbys, and the great achievements of Ross. The fact that the account of Ross's Antarctic voyage has never appeared in a popular edition is a mystery in the face of the frequent inquiries for that delightful book.

Dr. Fricker passes lightly over the early history of the Antarctic regions, not mentioning, we may note, Rainaud's excellent historical summary, "Le Continent Austral," in which the myth of the Great South Land is traced to its source. He takes up the work of Cook in the eighteenth century, of the Russian expedition under Bellingshausen, of Weddell, Biscoe, Balleny and the other sealers sent out by Messrs. Enderby Brothers, and deals in a thoroughly satisfactory manner with the simultaneous expeditions at the dawn of the Victorian era, when the French under Dumont d'Urville, the Americans under Wilkes and the British under Ross competed in the investigation of the south polar seas. Probably it was wise to pass lightly over the acrid controversy between Ross and Wilkes, although the English reader might have liked to see how such Homeric heroes assailed each other in the pages of the *Athenaeum* half a century ago.

The history of recent voyages stops with the trip of the *Antarctic* to Victoria Land in 1895. This was inevitable in the case of Dr. Fricker's German edition; but the translator might have endeavoured to convey, in a supplementary chapter, some idea of the great results which have been achieved since the first publication. It would only have been fair to the author to have given him the opportunity of revising his section on Bouvet Island, with which the detailed description of the various known lands of the Antarctic regions commences. The translator might at least have added a note to let the reader know that this interesting group, which was sought in vain by Cook and by Ross, was re-discovered by the *Valdivia* on November 25, 1898, during the first scientific voyage conducted by Germans to the edge of the Antarctic (see NATURE, vol. lx. p. 114).

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[1] "The Antarctic Regions," by Dr. Karl Fricker. Pp. xii + 292. Maps and Plates. (London: Swan Sonnenschein and Co., Ltd., 1900.)

"Through the First Antarctic Night, 1898-99. A Narrative of the Voyage of the *Belgica* among newly-discovered lands and over an unknown sea about the South Pole." By Frederick A. Cook, M.D., Surgeon and Anthropologist of the Belgian Antarctic Expedition. Illustrated. Pp. xxiv + 478. (London: William Heinemann, 1900.)